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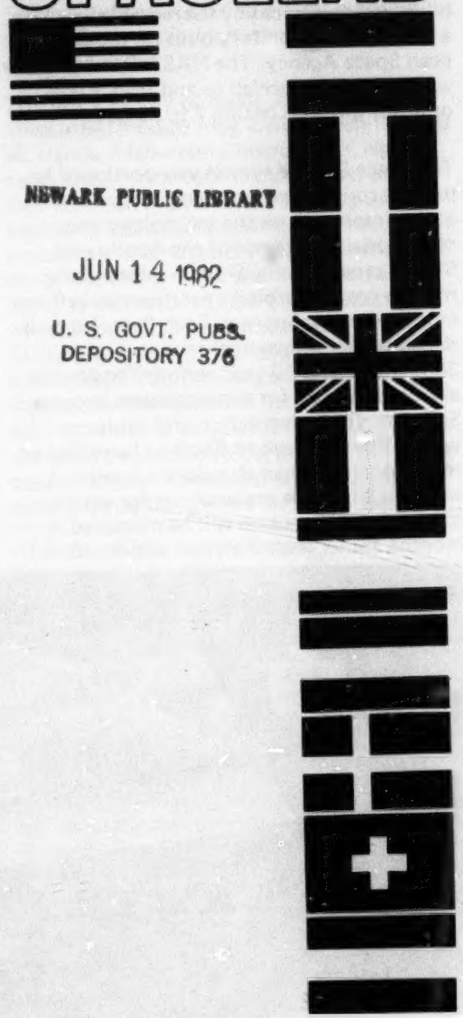
SPACELAB



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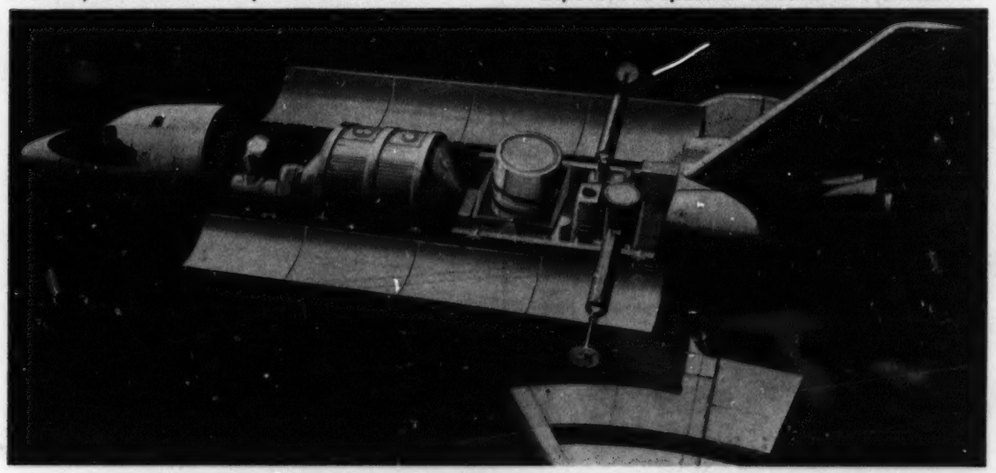
Throughout the next decade, non-astronaut scientists, engineers, and technicians will be conducting in-orbit experiments that require close human supervision. This unique capability will be offered by the reusable Spacelab, a spaceborne laboratory built by the European Space Agency. The NASA Space Shuttle will transport Spacelab to and from Earth orbit for missions lasting 7 to 30 days.

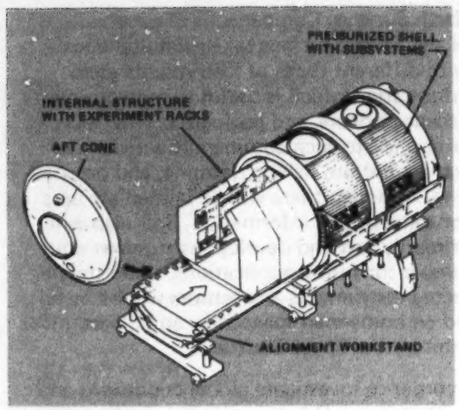
The Space Shuttle system was developed to provide routine and economical access to space. Improving on the technology and operational experience of the Apollo and Skylab programs, the Shuttle substantially reduces costs of orbital operations by reflying most major components. Each Spacelab is designed to be reflown many times — up to 50 flights over a 10-year period. The Shuttle also saves money for experimenters because Spacelab's instrumentation and equipment will be brought back to Earth to be reused or repaired, rather than abandoned in orbit. It saves time because preparations for experiments aboard Spacelab will be measured in months, rather than the years associated with automated satellites.

Spacelab will be transported in the 4.5x18-meter (15x60-foot) cargo bay of the orbiter, the orbiting element of the Space Shuttle system. As each mission is completed, an astronaut pilot will fire retro-rockets to lose orbital velocity, fly the orbiter through the atmosphere, and land it like a glider on a jet-sized airstrip.

Spacelab will have facilities similar to laboratories on Earth but adapted for operations in zero-gravity. It will provide a shirt-sleeve environment, like that in a passenger airliner, for both male and female experimenters. Spacelab will remain attached to the orbiter; scientists will eat and sleep in the orbiter throughout the mission. On return to Earth, Spacelab will be removed from the orbiter and outfitted for its next assignment.

Spacelab will have two main elements: a pressurized manned laboratory module and an external instrument platform, or pallet, for telescopes, antennas, and other large man-directed instruments requiring direct exposure to space or a broad field of view.





Both the pressurized portion of Spacelab and the segments of the pallet are modular in construction. Spacelab may be launched with one or two cylindrical shells, up to five pallet segments, or in various combinations.

Spacelab will be configured with experiments selected to meet mission requirements. These experiments can be attached to Spacelab mounting elements, such as the racks inside the pressurized shell or the non-pressurized pallet segments. Individual experiments will be brought to the Kennedy Space Center, and then integrated into the support systems in a particular Spacelab shell or pallet.

Payload specialists will normally supply and control the pallet-mounted instruments from within the pressurized module, but these researchers can also attend the instruments from the orbiter cabin in a "pallet-only" configuration. When only pallet segments are flown, essential subsystems can be carried in a pressurized and thermally controlled "igloo" attached to the cargo bay of the orbiter. Experiments mounted on the pallet may also be monitored and controlled from the ground, via the Payload Operations Control Center in Houston.

The pallets can also accommodate a variety of experiments where manned attendance is unnecessary yet certain services, such as temperature control and electric power, are needed. For experiments requiring precise pointing, an instrument pointing system can be mounted on the pallet.

To meet a variety of needs, an individual pressurized module may include such features as: standard laboratory instruments; equipment racks; work benches; windows; an airlock for small experiments requiring space exposure; and data recording and processing equipment. Instruments and equipment are contained in the "rack and floor combination," which is rolled into the Spacelab shell by means of a rail system. Several kilowatts of electricity in both AC and DC forms will be available. The Tracking and Data Relay Satellite System provides the capability to relay continuous voice communications and scientific data down to Earth. This will allow experimenters to maintain contact with colleagues on the ground for consultation.

As many as four researchers may staff a Spacelab mission. These payload specialists will be scientists and technicians, rather than professional astronauts. They will be healthy men and women of many nations, well-qualified in their fields, who will require only a few weeks of specialized training. This will include briefings on flight plans and procedures, including emergency procedures; familiarization with zero-gravity conditions; exercises in housekeeping during space flight; and simulation of the total system as it will function in actual flight operations.

Because these researchers will conduct their own experiments in orbit, the quality and reliability of the results are expected to be high. In many cases, the experimenters will go home with acquired data immediately after landing.

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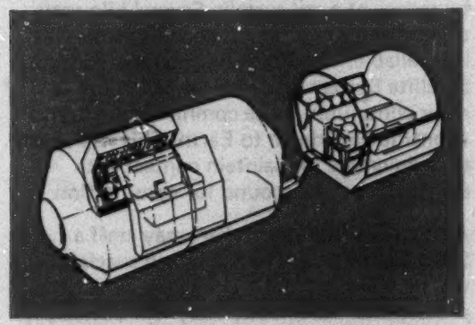
There will be many uses for Spacelab. Among them are the following:

Zero-g Studies in the Life Sciences. Space flight to date, by isolating the effects of gravity, has indicated interesting changes in man and suggested that there are metabolic and associated changes in plants and animals. Additional studies of these phenomena will advance medical and biological knowledge.

Materials Science and Technology. The absence of gravity in an orbiting laboratory and the nearly perfect vacuum of space will open new vistas for applied research on materials and techniques for orbital manufacturing. Ultrapure metals, semiconductors,

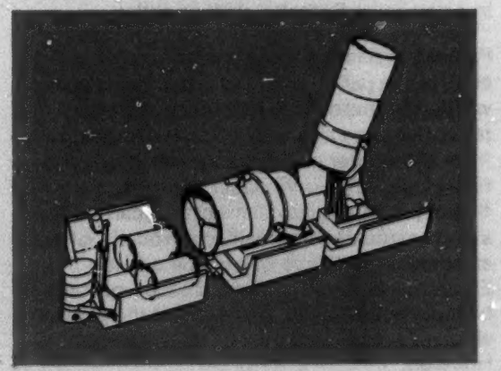


and glass may be produced through "containerless smelting." This method employs an electromagnetic field as a barrier to keep molten materials and plasmas from touching the walls of their containers. Nearly perfect crystals may be produced for use in computers, communications equipment, and for other applications in electronics. Without the influence of gravity, crystallization will occur without stratification. New types of composite materials with increased strength at high temperatures may be produced. In addition, knowledge acquired about materials while in orbit may advance processes now used on the ground.

Earth Surveys. Comparisons of observations of the Earth's surface taken simultaneously with different types of instruments yield information which is useful to meteorologists, oceanographers, and geologists. This data can be applied to such commercial activities as transportation, fishing, farming, and prospecting. Although there will be immediate uses for some of this information, Spacelab will primarily test and develop instruments and sensors for future applications. Later the perfected instruments and sensors will be installed on unmanned spacecraft, and placed into orbit by the Space Shuttle.

In order to investigate global conditions and resources, the Orbiter will often be flown in an inverted attitude, to orient Spacelab's instruments toward Earth.

Astronomical Observations. Celestial objects are best studied in orbit, above the obscuring atmosphere of the Earth. Spacelab will supplement larger orbiting instruments because it employs simpler instruments which can be quickly modified for special purpose flights. Spacelab can respond to unexpected opportunities, and hence can observe such transient astronomical events as the aurora borealis, novae, or the passage of a comet.



Biomedical Applications. The extremely stable, gravity-free environment of a space laboratory should prove ideal for several types of delicate methods used to separate and isolate specific biological materials. Such methods may be used to obtain highly pure preparations of particular types of cells for transplanting, to prepare concentrated antibodies for treating specific diseases, or to purify vaccines and other materials to eliminate contaminants with undesirable side effects. Initially these techniques will be employed on a small scale to support medical research, but if the materials developed are needed for large-scale use, they might be processed in space.

The Spacelab program lays a basis for greatly expanded international participation in space. Spacelab was designed and built by European contractors, under a program managed by the European Space Agency (ESA), to combined specifications of ESA and the United States. Furthermore, NASA and ESA are making Spacelab's availability, and resulting benefits, known to potential users in the international community.

NASA's responsibilities for technical support of ESA in its development of Spacelab are directed by the Marshall Space Flight Center in Huntsville, Alabama. Operation of Spacelab is also a NASA responsibility.

A new and economically feasible mode of conducting orbital research is soon to be at hand. With the Spacelab launched and recovered routinely as part of the Space Shuttle system, researchers from a wide variety of fields will be able to apply their own creative talents in orbit for the benefit of the world community.

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